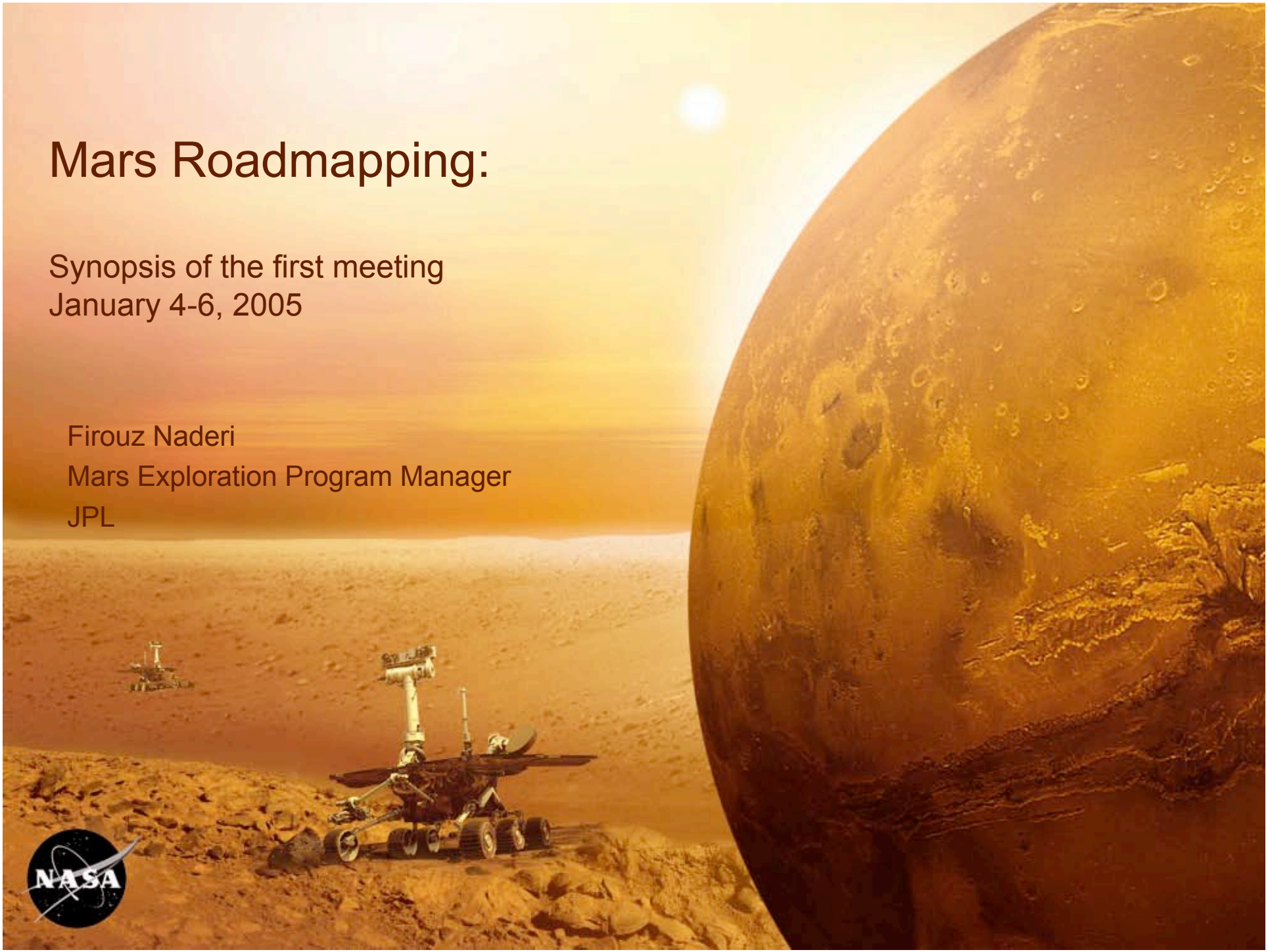
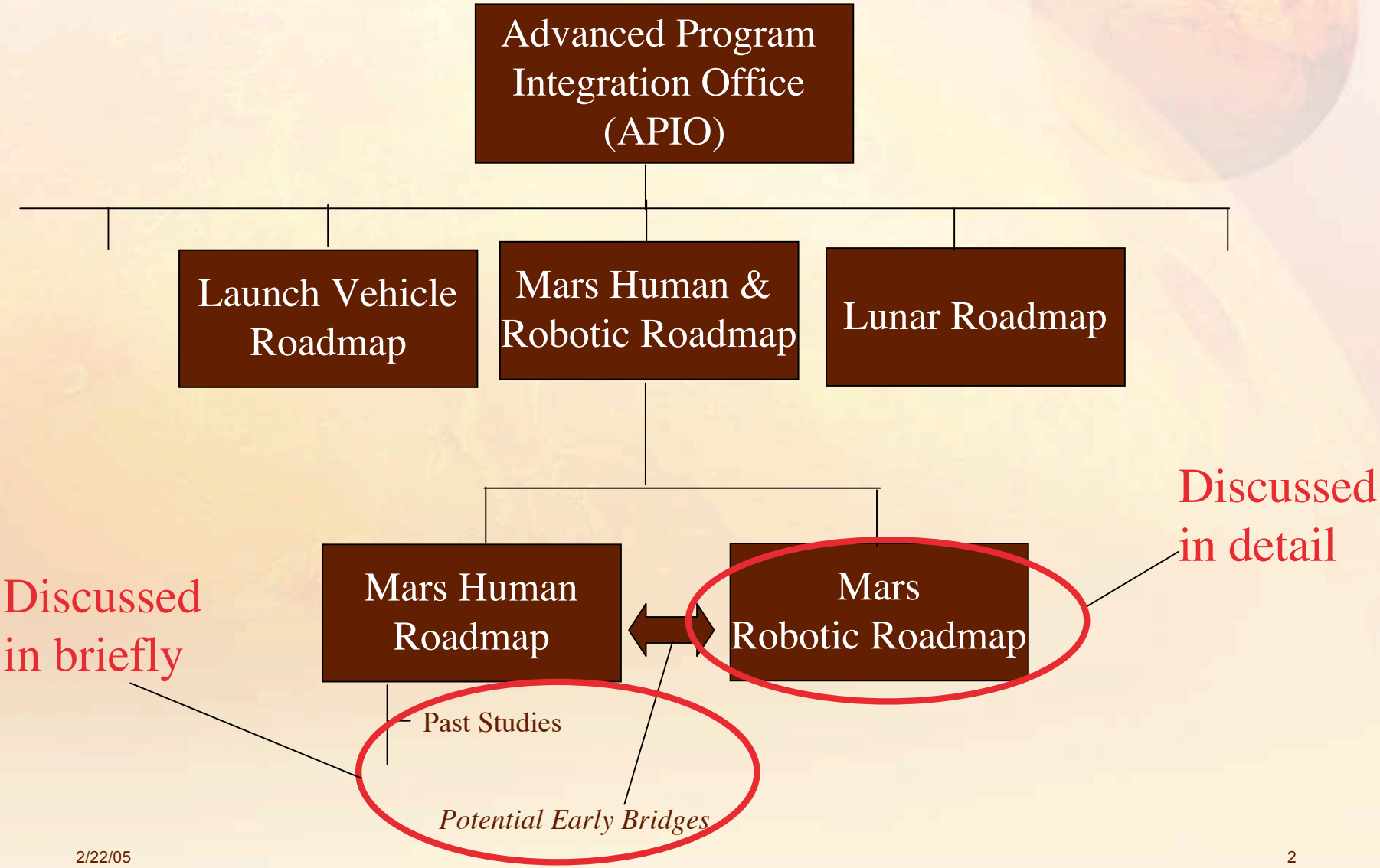
Mars Roadmapping:

Synopsis of the first meeting
January 4-6, 2005

Firouz Naderi
Mars Exploration Program Manager
JPL



What Was and Was not Discussed



NASA's Mars Exploration Program Objectives

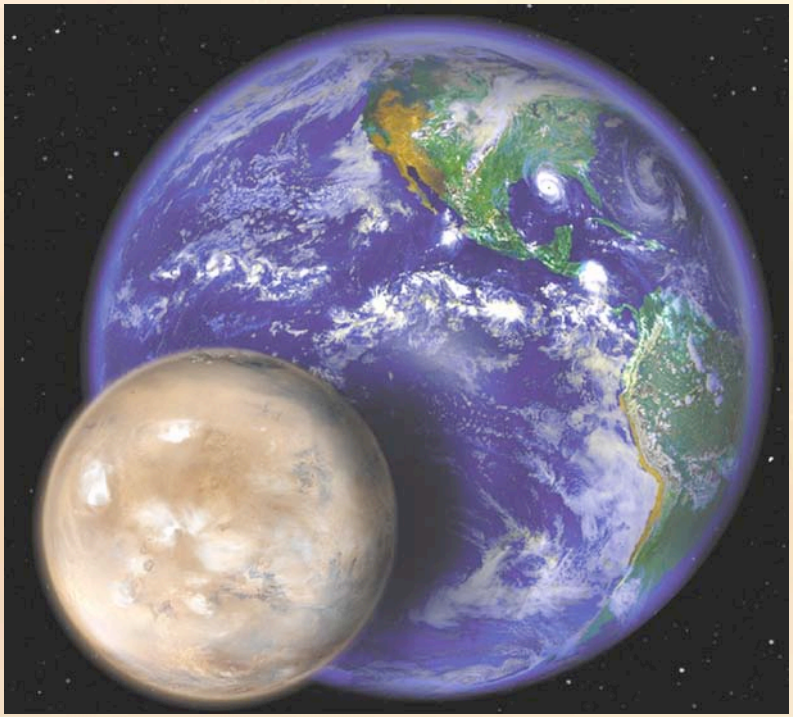
Was the environment on Mars ever right for emergence of life?

If so, did life emerge on Mars?

If it did, is there life on Mars now?

Where to Look?

- *Mars is a large planet (as much land surface as the Earth) and our resources are limited. Where on Mars should we look for an answer?*



- *Look in areas with **High Habitability Potential***
  - *Areas that have several elements considered necessary for life*
  - *Key*
    - *Water — where it might have been and, where it might be now*
    - *Complex carbon chemistry*

A Thought Process
How to Look

- *Once you have identified target areas with high habitability potential **how** do you look for life*

- *Look for the Organisms directly*
  - *Structure?*
- *Chemical biosignatures?*
  - *Life effects on environment e.g methane*
  - *Life residues e.g complex carbon molecules*
- *Others?*

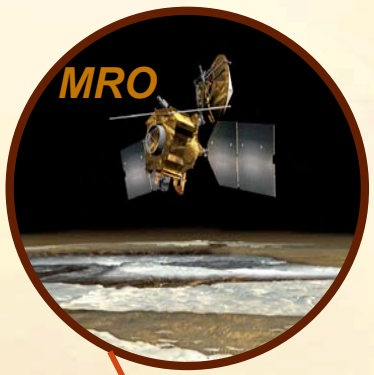
- *How Would you go about it?*
  - *Robotic In-situ?*
  - *Sample Return?*
  - *Humans?*

Elements of a Program

1. Orbital reconnaissance
   - Macroscopic exploration
   - Global context
   - Compass for the landed explorers
2. Landed explorers,
   - Microscopic follow through
   - Ground truth for orbiters observations
3. Sample return
   - More accurate analysis in Earth laboratories

Identifying Areas with High Potential for Habitability

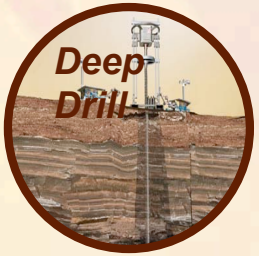
Orbital Reconnaissance



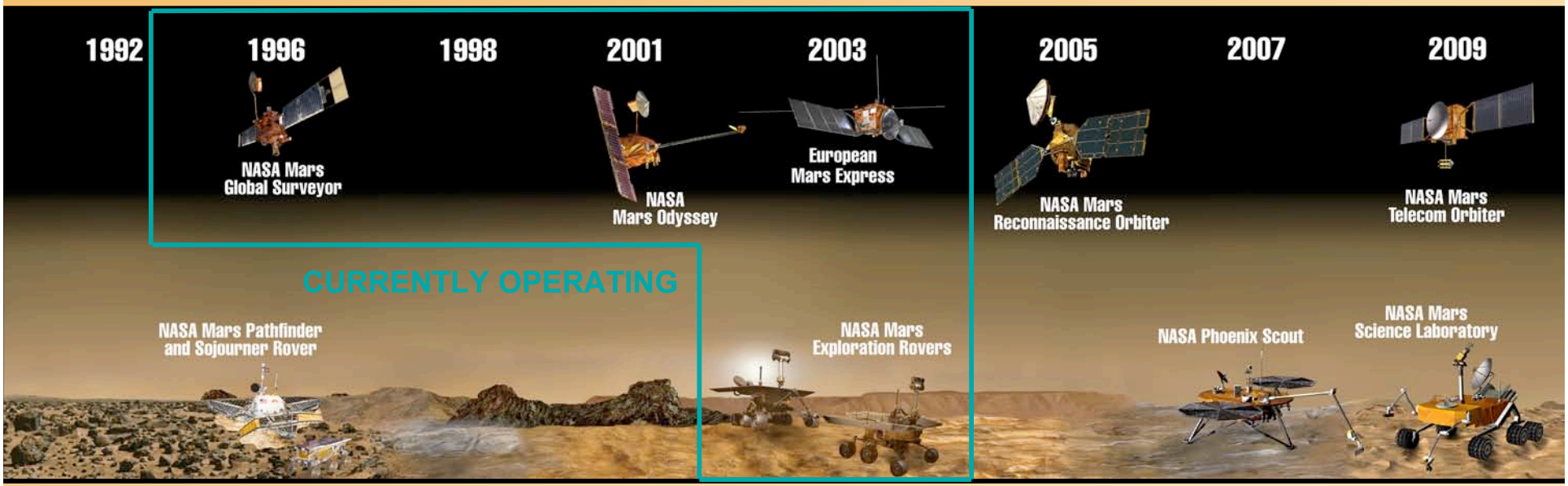
This Decade

Follow up In-situ Investigation (and Ground Truth)

Next Decade



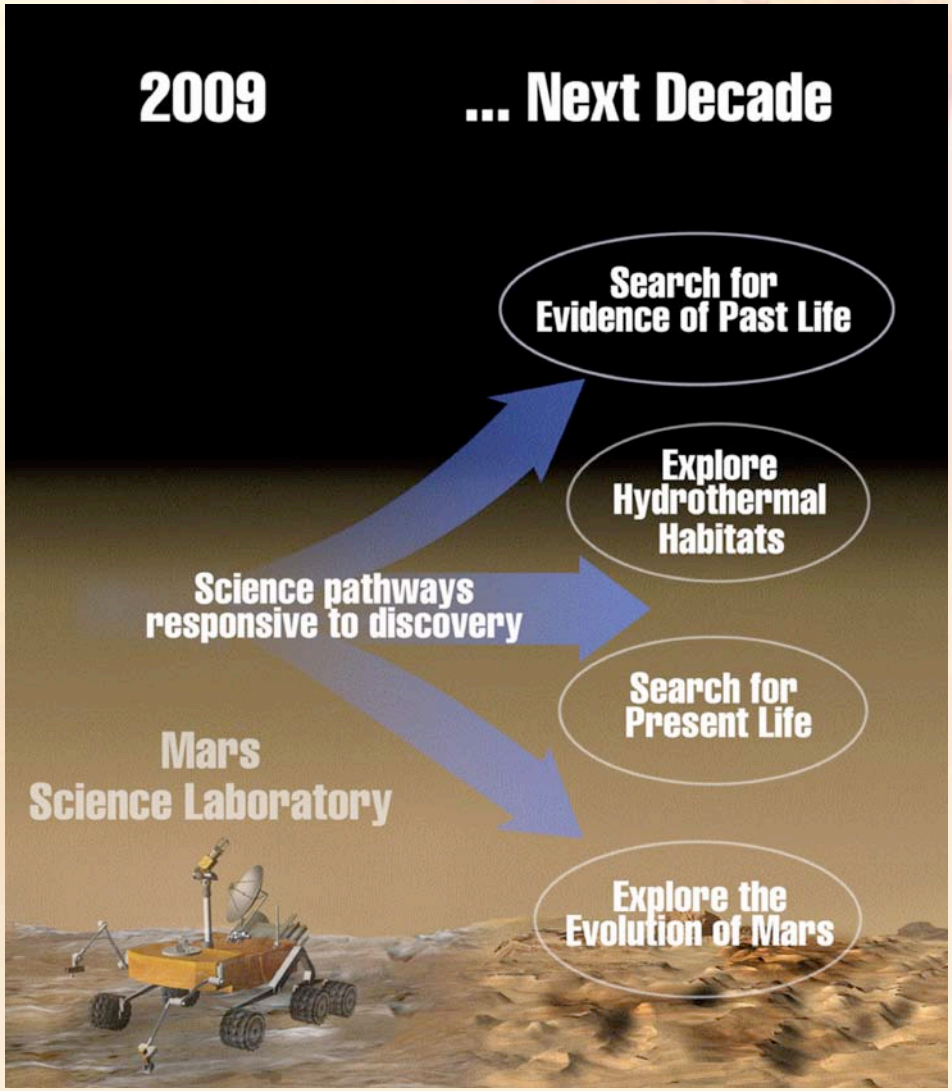
Current Decade Mars Exploration Missions



Follow the Water

Mars Exploration: Investigation Pathways

- In setting up a long-term robotic Mars exploration program, we had to be cognizant of the fact that:
  - Scientific discoveries yet to be made will alter current plans
  - Technology development will affect the pace of the program
  - Budget will always constrain the plan
- To remain resilient, particularly to scientific discoveries, future is defined in terms of a series of potential pathways — not a deterministic queue of missions



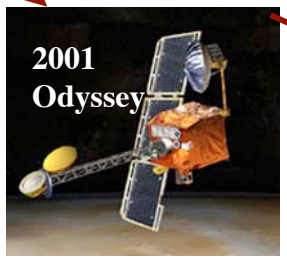
Mars Program:
An Interconnected Set Of Missions

Aerobraking

Atmosphere Monitoring for Aerobreaking

Aerobraking

Rendezvous & Capture



Regional Imaging

Landing Site Options

Com Relay

Com Relay

Com Relay

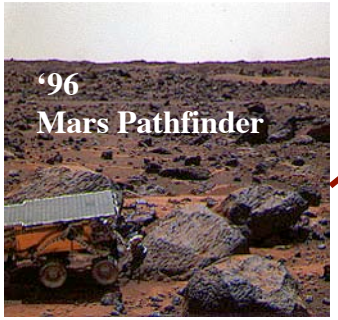
Com Relay

Com Relay

Com Relay

Landing Site Selection

In Situ Science



EDL System

EDL System Mobility

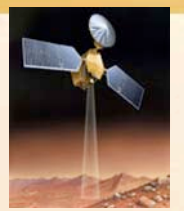
In Situ Science

MAV, Sample Containment

Technology Pipeline

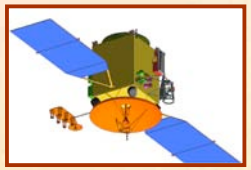
Paving the Road to Mars Sample Return

MRO



- Optical Navigation
- Site Survey
- Com. Relay

MTO



- Autonomous Rendezvous
- Com. Relay

MSL

- Guided Entry
- Precision Landing
- Potential Caching

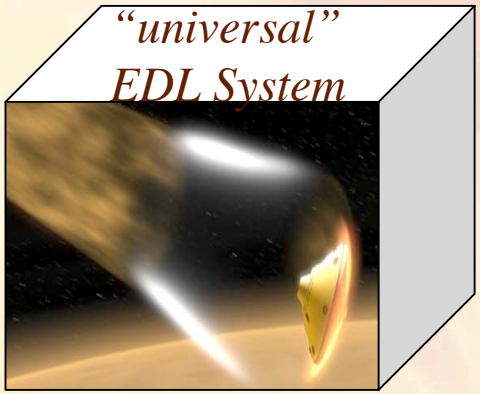
SOM

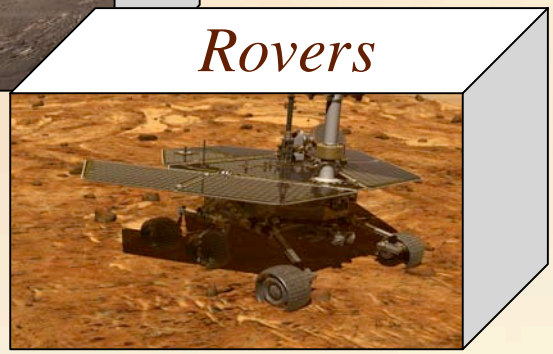
- Pinpoint Landing

MTP

- Mars Ascend Vehicle
- Planetary Protection

Missions Sequence — Built Out of Building Blocks





A Thought Process
How to Structure a Program

- *How do you structure a program that walks (runs?) through these steps?*

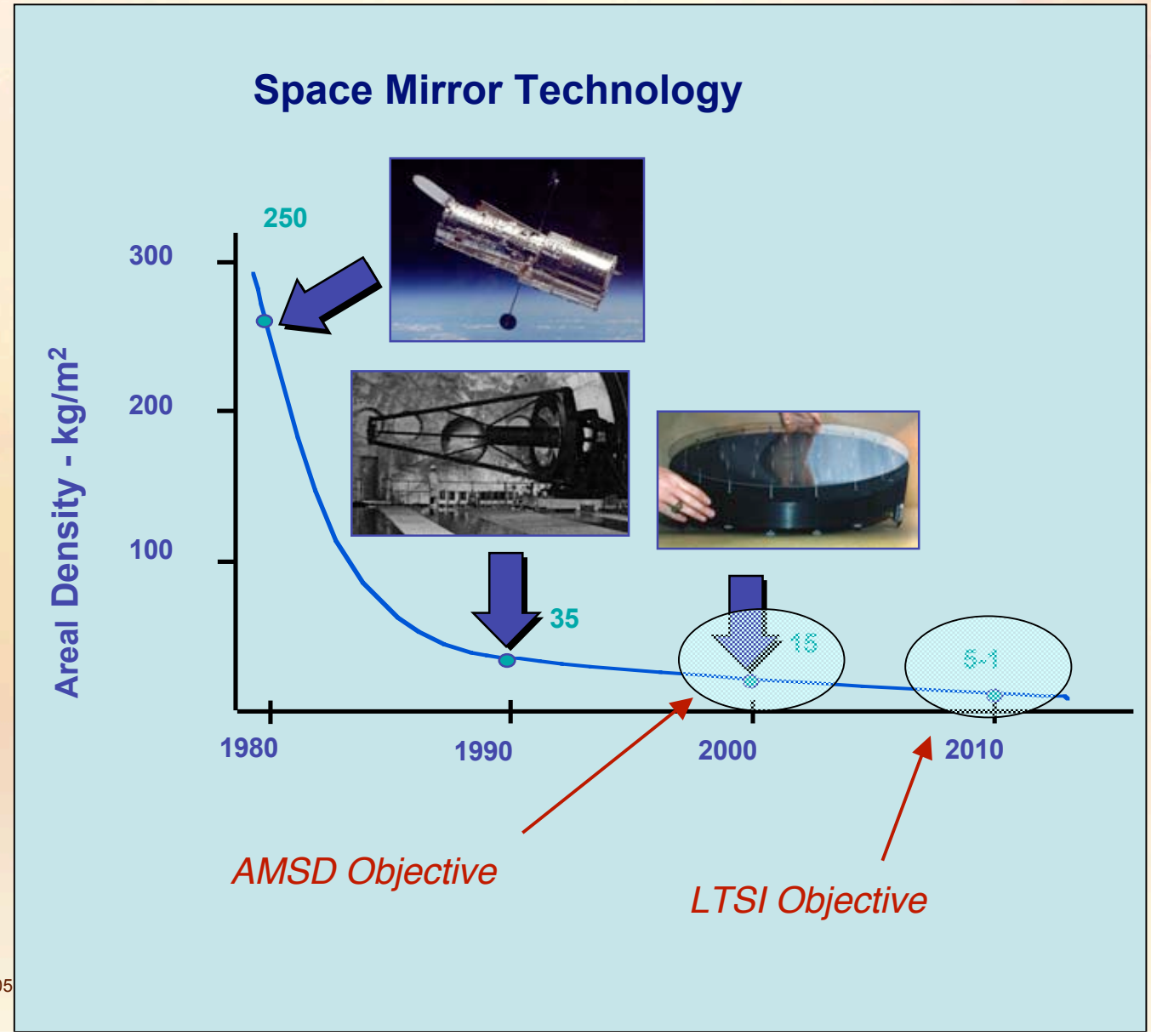
- *Linear/step by step/systematic*
  - *Does one worry about the stamina/attention span/patience of the public and resource providers if the process takes too long?*
- *Forget about the bunt single; Swing for the fences*
  - *How many strikes are you allowed?*
- *A hybrid approach?*

Connection to Human Exploration?

- *How do you couple the science driven robotic program with the emerging human program?*
- *What are the elements of each program that can be leveraged against the assets of the other?*

- *How do you feed forward science/technology/engineering*
  - *Between robotic and human missions*
    - *What will scale?*
    - *What requires technological paradigm shift?*

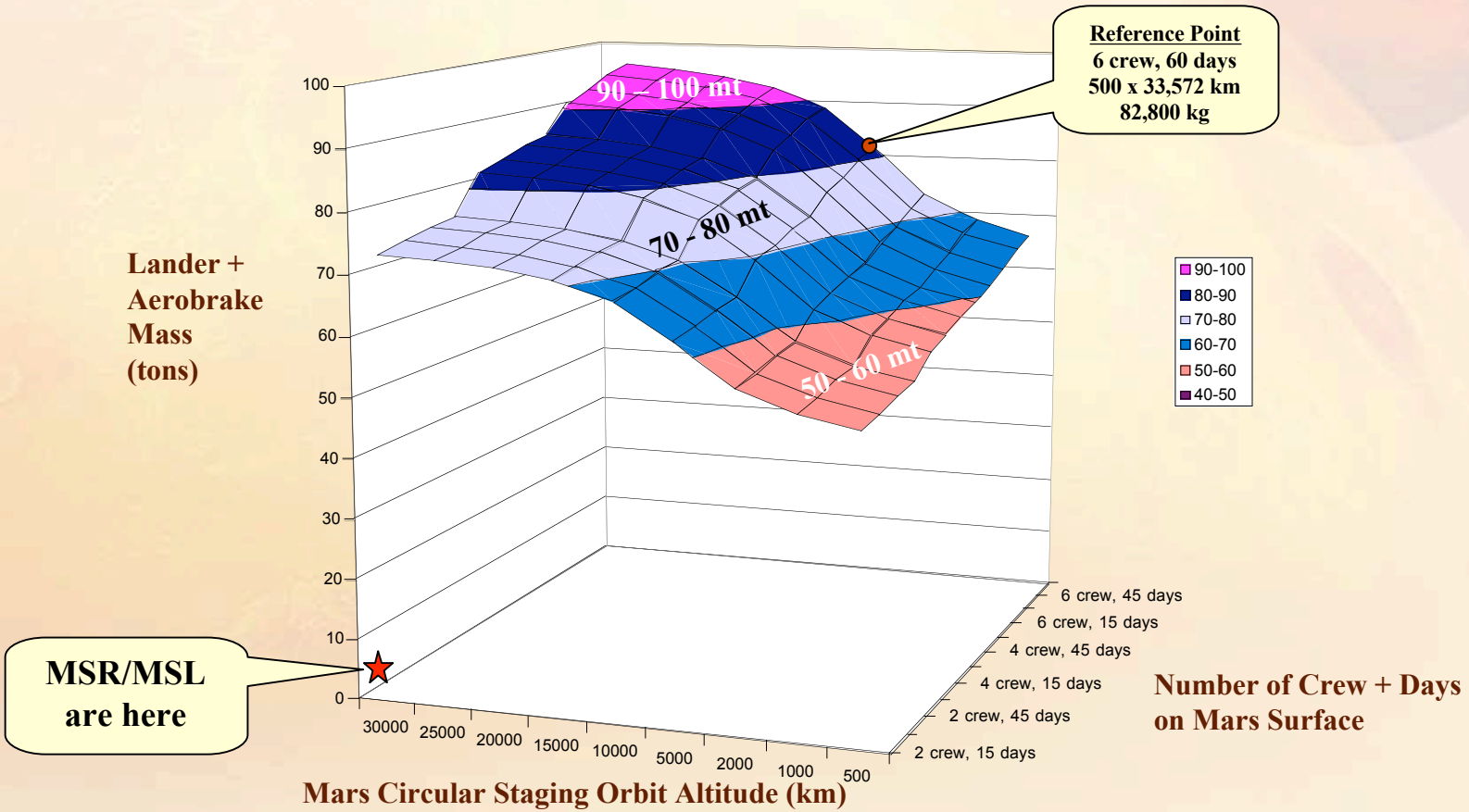
An Example of Evolving Technology



Scalability

Lander Mass at Mars Atmospheric Entry

- *Human missions will require landed masses in the tens of tons*



Courtesy: J. Geffre/JSC

Mars Exploration: Investigation Pathways

8) Structure a plan for developing a series of scenarios for human Mars exploration expeditions [and identifying key architectural drivers and key required capabilities.]

* Gerstenmaier, Connolly, Cameron, Lee, Lucid, Godwin, Naderi, Ride

3) Articulate the capabilities demos that need to be done to make human missions to Mars feasible and affordable. Identify if these demos should be done on

a) Mars Robotic missions,
b) the Moon,
c) the Space Station, or
d) the Earth.

Early demos should focus on capabilities with long-term "shelf life," i.e., that will still be applicable when they are needed. A time target is to have needed capabilities in place for decision to be made in 2020.

* Braun, Cameron, Cohen, Connolly, Godwin, Hinners, Manning

An Integrated Mars Science Program with MHP Activities